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ANALYSIS OF ESTABLISHING OPERATIONS FOR SELF-INJURY MAINTAINED BY ESCAPE

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Self-injurious behavior (SIB) can be maintained through negative reinforcement when, in the context of training or task requirements, it produces escape as a consequence. Several studies have demonstrated methods for identifying and treating SIB maintained by negative reinforcement; however, few analyses of the establishing operations associated with demand situations have been conducted. The current series of studies illustrates a method for identifying some establishing operations for escape by systematically altering certain dimensions of the demand context while maintaining an escape contingency for SIB. Dimensions assessed in these studies included task novelty, duration of instructional sessions, and rate of task presentation. Data indicate that these variables can have establishing properties for behavior maintained by escape. Implications of the results are discussed, as are potential refinements and extensions of the assessment procedures.

DESCRIPTORS: functional analysis, establishing operations, escape behavior, self-injurious behavior, negative reinforcement

A number of studies have shown that self-injurious behavior (SIB) can be maintained by social reinforcement, often in the form of attention from adults or escape from task demands. Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) developed a method for assessing these relationships, and subsequent research has elucidated the implications of this methodology for treatment (see Iwata, Vollmer, & Zarcone, 1990, and Mace, Lalli, & Lalli, 1991, for reviews). This function-analytic approach has been extended to the assessment and treatment of a wide range of behavior disorders, including stereotypy (Mace, Browder, & Lin, 1987), tantrums (Carr & Newsom, 1985), inappropriate verbalizations (Pace, Ivancic, & Jefferson, 1994), and aggression (Mace, Page, Ivancic, & O'Brien, 1986). Although most research has focused on the identification of reinforcement contingencies that maintain maladaptive behavior, recent studies also show growing interest in the antecedent conditions associated with behavior disorders (e.g., Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991; Durand & Crimmins, 1987, 1988; Kennedy, 1994; Kennedy & Itkonen, 1993; Mace & West, 1986). These studies have attempted to identify, and often to manipulate as treatment, antecedent conditions that set the occasion for maladaptive behaviors.

Although several antecedent interventions have been effective in reducing the frequency of maladaptive behavior, the functional properties of these interventions often remain unclear. That is, relations between antecedent treatments and positive outcomes have been shown;

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however, it is rarely possible to identify the behavioral mechanisms that underlie these relations. Although antecedent interventions represent important additions to a technology of behavior change, advancement of the applied science requires methods for relating procedural variations to basic principles (Baer, Wolf, & Risley, 1968).

The functional properties of antecedent conditions may be classified according to two fundamental relations. First, discriminative events are stimuli that are differentially correlated with a specific contingency of reinforcement or punishment (Skinner, 1953). Such conditions acquire evocative or suppressive properties relative to a response based on an historical relationship between the response and its consequences. A second fundamental relation among antecedent events, behavior, and consequences is the establishing operation (Keller & Schoenfeld, 1950; Michael, 1982), which alters both the reinforcing effectiveness of specific consequences and the momentary probability of occurrence for behaviors that have previously produced those consequences. Thus, in the presence of stimuli that are discriminative for a specific response–consequence relationship, the probability of the occurrence of that response may be altered by establishing operations that increase or decrease the reinforcing effectiveness of that consequence. Further, Michael (1982) proposed that the onset of aversive stimulation is an establishing operation for its own offset. That is, in the negative reinforcement paradigm, the reinforcing effects of escape from ongoing stimulation are established by the presence of such stimulation. Although this relation has often been characterized in terms of discrimination (e.g., Carr, Newsom, & Binkoff, 1976; Kennedy, 1994; Touchette, MacDonald, & Langer, 1985), Michael presented cogent arguments for its interpretation as an establishing operation (Michael, 1982, 1988, 1993a, 1993b).

Few studies have attempted to classify the effects of antecedent events on behavior disorders according to fundamental properties. It is difficult to investigate discriminative operations using solely antecedent-based procedures because discriminative control requires a correlation between antecedent conditions and a reinforcement contingency. Thus, studies on stimulus control must arrange either to maintain or establish stimulus control by controlling both antecedents and consequences. The examination of establishing operations for escape-maintained behavior is an especially promising topic for research because the events that establish their own termination as a reinforcing outcome (e.g., task demands) are themselves socially mediated. These stimuli almost always are both presented and withdrawn by teachers, parents, or other caregivers, and so are amenable to experimental manipulation. A more complete understanding of establishing operations may promote the development of more effective methods for assessing and treating behavior problems that are maintained by escape.

The current series of studies presents a relatively simple yet general methodology for identifying establishing operations for negatively reinforced behavior. After first verifying through a functional analysis that SIB was maintained by escape (Study 1), some establishing properties of task demands were investigated. While continuing to terminate training trials as a consequence for SIB, aspects of response patterns were analyzed (Studies 2 and 3), or a dimension of the task trial was altered (Study 4) to assess establishing operations.

GENERAL METHOD

Subjects and Setting

Nine individuals with developmental disabilities participated in one or more of four studies. All lived in a public residential facility, and all had previously received a diagnosis of profound mental retardation. The subjects were referred to a specialized program for assessment and treatment of their SIB.

Walter was a 31-year-old man whose SIB consisted of hand biting. He displayed no ex-

pressive language skills, but he was able to respond to a few simple requests. Walter participated in Studies 1 and 2. Landon was a 44-year-old man whose SIB consisted of head and body hitting, head banging, and hand biting. He did not show expressive verbal skills, but he was able to respond to some simple directions. Landon participated in Studies 1, 2, and 4. Olivia was a 27-year-old woman whose SIB consisted of head hitting. She was deaf and blind, she did not show expressive language skills, and was not responsive to directions from caregivers. Olivia participated in Studies 1 and 4. Larry was a 46-year-old man whose SIB consisted of head hitting and hand biting. He wore a protective helmet when he was not participating in assessment or treatment sessions, partly due to his SIB and partly because he occasionally fell due to an unsteady gait and infrequent seizures. Larry had no expressive language skills, and he responded to a few simple requests. Larry participated in Studies 1, 3, and 4. Carl was a 38-year-old man whose SIB consisted of head hitting and banging and arm and wrist biting. He did not exhibit expressive verbal skills but was responsive to a limited number of requests from caregivers. Carl participated in Studies 1, 3, and 4. Stan was a 47-year-old man whose SIB consisted of head and body hitting and head banging. He displayed some echolalic vocalizations, and he responded to simple directions. Stan participated in Studies 1, 3, and 4. Helen was a 28-year-old woman whose SIB consisted of head and body hitting, including knee-to-head contact. She did not exhibit expressive language skills, but she was responsive to several requests from caregivers. Helen participated in Studies 1, 3, and 4. Evelyn was a 33-year-old woman whose SIB consisted of head and body hitting, head banging, and hand biting. She had a limited verbal repertoire consisting exclusively of vocal mands for reinforcers such as candy and cookies, and she appeared to understand a few simple directions. Evelyn participated in Studies 1 and 3. Milt was a 43-year-old man whose SIB consisted of head banging and body hitting. He did not display expressive language skills, and he responded to only a few simple requests from caregivers. Milt participated in Studies 1 and 3.

Sessions were conducted at a day program for the assessment and treatment of SIB located on the grounds of the residential facility. Therapy rooms contained chairs, tables, and other furnishings, as well as materials that varied according to the conditions of the assessment (see Procedure section of Study 1). Sessions lasted for 15 min unless otherwise noted. Between one and four sessions were conducted each day, and sessions typically were conducted five days per week.

Response Measurement and Reliability

SIB was operationally defined for all subjects as follows: ***head hitting*** (Carl, Evelyn, Helen, Landon, Larry, Olivia, Stan): forceful contact against any part of the the face or head by any other portion of the body, including open hands, fists, and knees; ***head banging*** (Carl, Evelyn, Landon, Milt, Stan): forceful contact by the head against walls, furniture, or floors; ***hand or arm biting*** (Carl, Evelyn, Landon, Larry, Walter): contact of the mouth or teeth against any area of the hand, wrist, or arm; and ***body hitting*** (Evelyn, Landon, Helen, Milt, Stan): forceful contact of one body part against another, other than the head (e.g., fist against torso, elbow against legs, etc.). Data on compliance are reported for Studies 2 and 4. Compliance was defined as performance of the requested task without SIB or physical assistance from the therapist.

Data were collected using hand-held computers (Assistant Model 102) and (unless stated otherwise in Method sections) were calculated as number of occurrences of SIB per minute by dividing the number of self-injurious responses by the number of minutes of session time. A second observer simultaneously but independently recorded data during 38.2% of all observations (37.4% of sessions in Study 1, 30.2% of sessions in Study 2, 38.4% of sessions in Study 3, and 47.7% of sessions in Study 4).

Interobserver agreement scores were calculated by first dividing session time into consecutive 10-s intervals. The smaller number of responses was divided by the larger number of responses recorded during each interval, and those values were averaged across the session. Mean agreement for SIB was 98.6% (range, 80.1% to 100%) during Study 1, 96.7% (range, 85.1% to 100%) during Study 2, 97.6% (range, 89.8% to 100%) during Study 3, and 97.3% (range, 89.8% to 100%) during Study 4. Mean agreement for compliance was 99.9% (range, 98.8% to 100%) during Study 2 and 98.2% (range, 91.9% to 100%) during Study 4.

STUDY 1: FUNCTIONAL ANALYSIS OF SIB

All subjects participated in Study 1, in which an experimental analysis was conducted to verify that each subject's SIB was maintained by escape. The procedures were based on those described by Iwata et al. (1982/1994).

Method

The assessment consisted or four conditions, three of which represented a contingency for SIB analogous to those observed in the natural environment. The fourth condition was presented as a control. The conditions were presented to each subject in a multielement experimental design and are described below.

Demand. The subject was placed in a therapy room with task materials present. A variety of tasks similar to those found in subjects' habilitation plans was presented each session. Each demand was a simple one-step request that could easily be completed within 10 to 15 s. The experimenter initiated learning trials with the subject approximately every 30 s, using a graduated prompting procedure (verbal instruction, visual prompt, physical guidance) at 5-s intervals if compliance did not occur. If compliance occurred, the therapist delivered praise, and the trial was terminated. If SIB occurred, the experimenter turned away from the subject, and no further instructions were presented until the next scheduled trial. SIB that occurred within 5 s of the next scheduled trial delayed that trial for 5 s. This condition was conducted to determine if SIB was maintained by negative reinforcement in the form of escape from task requirements. A variation of this condition (music) was conducted for Milt, who had been observed to engage in SIB in the presence of loud noises. Milt was placed in a room in which music was played continuously but was turned off for 20 s contingent upon SIB. This condition assessed whether Milt's SIB was maintained by cessation of noise.

Attention. The subject was placed in a therapy room with leisure materials available. The experimenter directed the subject toward the materials, then engaged in other activities while remaining in the presence of the subject (e.g., seated in a chair across the room). If the subject engaged in SIB, the experimenter approached the subject and provided brief attention, in the form of social disapproval or concern, and brief physical contact (e.g., hand on shoulder or response blocking). Responses other than SIB were ignored. This condition was conducted to determine if SIB was maintained by positive reinforcement in the form of attention from caregivers.

Alone. The subject was placed in a therapy room alone, with no toys or other materials available. This condition was conducted to determine if SIB persisted in the absence of social contingencies, suggesting that the behavior was maintained by nonsocial (automatic) reinforcement of some sort.

Control. In this condition, the experimenter provided attention approximately every 30 s (contingent upon a 5-s absence of SIB), and the subject had continuous access to toys and games. The subject received no task demands in this condition, and SIB produced no social consequences. The purpose of this condition was to serve as a control for SIB (very little SIB was expected to occur because of a high level

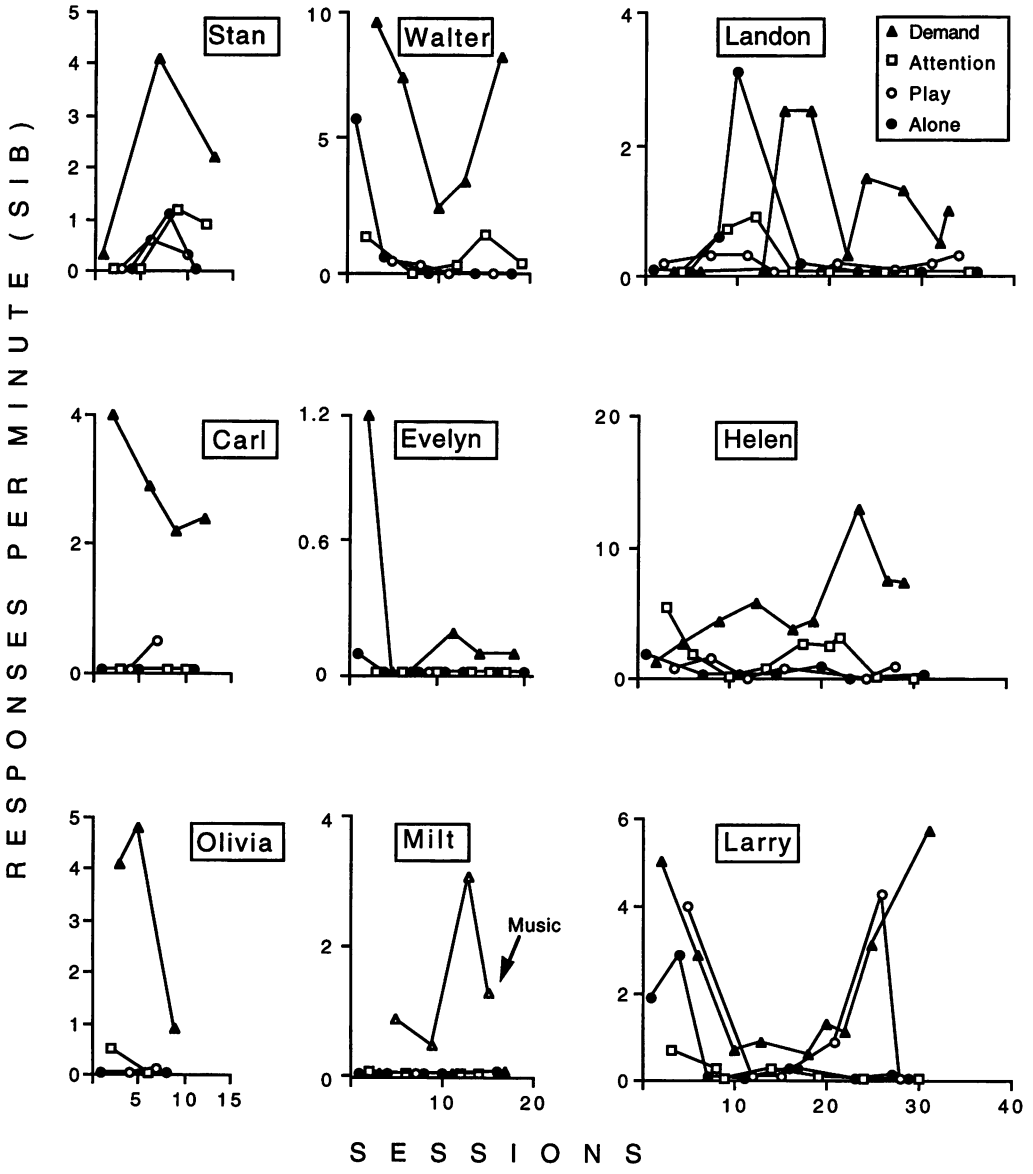


Figure 1. Functional assessment results for all subjects.

of noncontingent attention, the absence of task demands, and access to stimulating materials).

Results and Discussion

Results of the functional analysis of SIB revealed that all subjects except Milt showed highest levels of SIB in the demand condition; Milt's SIB occurred most frequently in the condition designed to assess whether escape from ambient noise maintained his SIB. The results of individual assessments are presented in Figure 1. Results for Stan, Walter, Carl, Olivia, and Milt showed immediate differentiation, with no overlap between demand (music for Milt) and other assessment conditions. Evelyn's SIB occurred at a relatively high rate during the first demand session, and then decreased and stabilized at lower levels; no SIB occurred in any other condition after the first session. Thus, data showed very clear response patterns within

9 to 20 sessions for 6 subjects; however, extended assessments were required to reveal the functions of Landon's, Larry's, and Helen's SIB. Landon's SIB initially occurred at low levels in all conditions, perhaps due to a failure of his behavior to come under control of the various contingencies. Following the 15th session of assessment, Landon's SIB was consistently highest in the demand conditions, relative to others. Larry's SIB did not differentiate for several sessions, and he continued to display variable rates of SIB in the control condition throughout his assessment. This may have been due to similarities between the demand and control conditions (e.g., presence of materials, approach of the experimenter at 30-s intervals), which could have interfered with discrimination between them. Results of recent research suggest that the mere presence of a trainer may be a conditioned aversive event for some individuals (Taylor & Carr, 1992; Taylor, Ekdahl, Romanczyk, & Miller, 1994); thus, experimenter approach in the control condition may occasion SIB that is maintained by escape from social interaction in general, and subsequent withdrawal of experimenter attention may adventitiously reinforce such responding. Therefore, an escape account for Larry's SIB is not inconsistent with the continued occurrence of some SIB in the control condition. Helen's SIB differentiated after her second exposure to each condition; she then displayed consistently highest rates of SIB in the demand condition. SIB continued to occur at moderate levels in the attention condition until the eighth session, raising the possibility that her SIB was multiply controlled by escape from task trials and attention from caregivers. However, SIB eventually decreased to zero or near-zero rates during all conditions except demand.

In summary, the results of Study 1 suggested that one or more features of the demand context (music for Milt) served to establish escape as a reinforcer for these individuals. These outcomes were the basis for inclusion of the subjects in subsequent studies. Studies 2, 3, and 4 examined the potential establishing properties of task novelty, session duration, and rate of task trials. Subject assignments across these studies were based upon availability of subjects, treatment considerations, and the time during which specific studies were conducted.

STUDY 2: EFFECTS OF TASK NOVELTY ON SIB

Mace et al. (1987) found that subjects exhibited higher levels of inappropriate behavior when presented with novel versus familiar tasks (spreading peanut butter on crackers rather than making instant hot chocolate, peeling a hard boiled egg, making cinnamon toast, and making instant pudding), suggesting that task novelty may serve as an establishing operation for escape behavior. However, because the tasks were dissimilar in several respects, it is possible that the novel tasks may have contained other features that were associated with increases in stereotypy (e.g., response duration, effort, etc.), and that novelty alone may not have produced higher levels of maladaptive behavior.

This study examined the effects of task novelty on escape-maintained SIB by exposing subjects to task demands that had not previously been presented in the experimental situation. By presenting each new task repeatedly, it was possible to examine the course of responding across sessions as subjects developed a history with each demand (i.e., during the transition of demands from novel to familiar, by definition). If task novelty did serve as an establishing operation for escape behavior, then a decrease in SIB would be expected to occur after repeated exposure to specific tasks, even if SIB continued to produce escape from task trials.

Method

Walter and Landon participated in Study 2. The experimental procedures previously described for the demand condition in Study 1 were in effect throughout Study 2, with the exception that sessions consisted of repeated pre-

sentations of a single task demand rather than a variety of demands.

A combined multiple baseline and multielement experimental design was used to assess the effects of task novelty on SIB. Following at least three consecutive sessions in which rates of SIB stabilized or showed a decreasing trend and occurred at rates below 0.5 responses per minute, a new demand was presented in separate sessions. Occasional sessions with the immediately previous task demand continued in order to assess potential covariation in SIB across tasks. Although this arrangement does not represent a traditional experimental design, it does provide for both inter- and intrasubject replications of the response patterns produced as initially novel tasks become increasingly familiar. For Walter, two sessions were conducted with tasks that initially occasioned less than 0.5 responses per minute of SIB, and for Landon, three sessions were conducted with tasks that initially occasioned less than one response per minute of SIB. Because these tasks were associated with low levels of escape responding, no further sessions were conducted with them, and data from those sessions are not presented here.

In order to determine if any observed reductions in SIB were due to decreasing task novelty (i.e., whether novelty was an establishing operation), data were collected on two dependent variables—the percentage of trials with escape and the percentage of trials with compliance. If the percentage of trials escaped did not decrease (or increased) over time, then decreases in SIB may have merely been a function of improved control over SIB by the schedules of task trial presentation and withdrawal, rather than diminution of the reinforcing effects of escape due to repeated task presentation. That is, experience with the continuous reinforcement schedule for SIB may have produced more efficient responding, allowing the rate of SIB to decrease while the percentage of trials escaped remained stable (or perhaps increased). The percentage of trials with escape (i.e., trials during which SIB was scored) was calculated for each session by dividing the number of trials with SIB by the total number of trials. If increases in compliance were observed across sessions, then decreases in SIB may have been due to the indirect effects of increased reinforcement for compliance rather than establishing operation effects of repeated presentation of tasks.

Results and Discussion

The results of Study 2 are presented in Figure 2, which shows the percentage of trials with SIB (escape) and compliance for Walter. Demand 1 initially occasioned SIB during 48% of trials, which decreased to zero over 14 sessions (the mean percentage of escape during the final three sessions with Demand 1 was 6%). Sessions with Demand 2 were introduced following the 11th session with Demand 1. Although initial levels of SIB were lower with Demand 2 than with Demand 1 (34% of trials occasioned SIB in the first session), the decreasing pattern of escape seen with Demand 1 was replicated with Demand 2 (the mean percentage of trials with SIB during the final three sessions with Demand 2 was 5%). After the sixth session with Demand 2, sessions with Demand 3 were introduced. SIB occurred during 28% of trials in the first session with Demand 3, and the trend with Demand 3 replicated that seen with Demands 1 and 2; trials with SIB decreased to zero over 11 sessions (SIB never occurred during the final three sessions with demand). Walter's rate of SIB (not shown in Figure 2) closely followed the patterns shown by percentages of trials with SIB, decreasing from 5.6 responses per minute during the first session with Demand 1 to a mean of 0.06 responses per minute during the final three sessions; from 1.7 responses per minute during the first session with Demand 2 to a mean of 0.09 responses per minute during the final three sessions; and from 3.0 responses per minute during the first session with Demand 3 to a mean of 0.02 responses per minute during the final three sessions. Walter exhibited compliance during only two sessions; once during

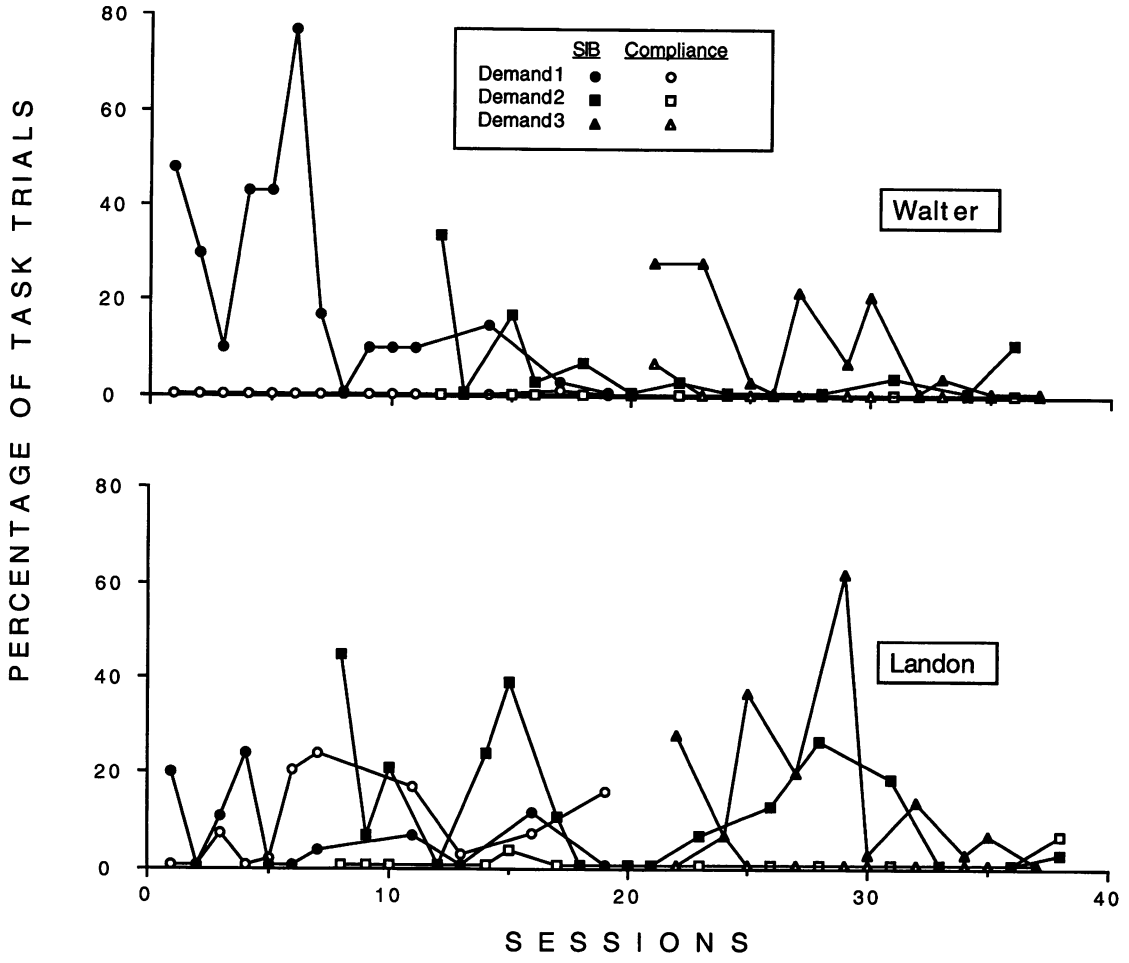


Figure 2. Results of Study 2 for Walter and Landon. Filled symbols represent percentages of task trials with SIB, and open symbols represent percentages of task trials with compliance.

the 13th session with Demand 1 and twice during the initial session with Demand 3.

Landon's data are also shown in Figure 2. Landon escaped 20% of the trials during his first session with Demand 1. Some variability was observed over the next several sessions, after which the percentage of trials with SIB stabilized below 12% and eventually decreased to zero by the 11th session (the mean percentage of trials with SIB during the final three sessions with Demand 1 was 4%). Following the seventh session with Demand 1, sessions with Demand 2 were introduced. Landon's SIB occurred during 46% of trials in the first session with Demand 2. After a decrease in responding to zero trials with SIB for three consecutive sessions, SIB recovered coincident with the introduction of Demand 3. Following this recovery, SIB again decreased to a mean of 1% during the final three sessions with Demand 2. Sessions with Demand 3 were introduced following the 10th session with Demand 2. SIB occurred during 28% of the trials in the first session with Demand 3. An increasing trend was observed over the first five sessions, after which the percentage of trials with SIB decreased to a mean level of 3% during the final three sessions with Demand 3.

Data on Landon's compliance with task demands showed a slight increase for Demand 1,

although compliance never exceeded 24%, and the mean level of compliance over the final three sessions with Demand 1 was 8%. Landon seldom complied with Demands 2 and 3, showing no compliance during initial sessions and mean levels of compliance of 2% and zero for the final three sessions with Demands 2 and 3, respectively.

The results of Study 2 suggest that novel tasks may serve as establishing operations for escape. That is, the reinforcing effects of escape from a given task may be increased merely as a function of the extent to which the task is unfamiliar. After repeated presentation of the same tasks, escape behavior showed decreasing trends for both Walter and Landon. It is important to note that different tasks can vary in their aversive properties independent of novelty; thus, interpretation of the current data is based on within-task trends in percentages of trials with SIB, replicated across tasks. Thus, overlap in percentages of trials occasioning SIB between familiar and novel demands (e.g., Demands 1 and 2 with Walter) may be a function of differences in task aversiveness that were unrelated to novelty. Because the escape contingency remained unchanged throughout the study, the decreasing trends in escape behavior can be attributed to diminutions in the reinforcing effects of escape from those tasks, rather than to an alteration in a contingency or to extinction. Thus, the apparent degradation of the aversive properties of specific tasks appears to have occurred as a function of repeated exposure to those tasks.

An alternative account for these data is that SIB may have decreased as a function of reinforcement for an alternative response (i.e., compliance). However, this account would require trends in compliance in the opposite direction of those for SIB (i.e., increases in compliance concurrent with decreases in SIB). In the present study, compliance never exceeded 25%, and the slight increase in Landon's compliance with Demand 1 was not replicated with Demands 2 or 3. Thus, it is unlikely that decreases in SIB for Walter and Landon occurred as a function of increases in compliance.

An unanticipated effect of the introduction of Demand 3 for Landon was an increase in the percentage of trials occasioning SIB with Demand 2. The reason for this finding is unclear, but it may be that concurrent experience with a highly aversive stimulus (i.e., Demand 3) may increase the escape-establishing effects of less aversive stimuli (i.e., Demand 2). Alternatively, the increase in escape from Demand 2 concurrent with the introduction of Demand 3 may have been related to an uncontrolled and unidentified extraneous variable affecting both conditions. Both of these explanations are plausible, and the data do not permit definitive interpretation.

The results of Study 2 indicate that, in addition to measuring the occurrence of SIB (e.g., either rate or percentage of intervals), it is important to collect data on both the percentage of tasks escaped and compliance in order to distinguish from among three possible accounts when escape-maintained SIB decreases under conditions in which trial termination is contingent upon it: (a) that the escape-establishing function of demands decreases, (b) that compliance increases due to learning and reinforcement effects, or (c) that escape behavior comes under better control of schedules of task presentation and escape as a consequence. This distinction may be important when developing treatment plans for individuals whose maladaptive behavior is maintained by escape. First, for individuals whose escape behavior is sensitive to novelty as an establishing operation, it may be helpful to minimize the novelty effects by arranging for new tasks to be as similar as possible to previously learned tasks. In addition, knowledge that task familiarity reduces the occurrence of escape behavior may permit trainers to refrain from using escape extinction (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990) and thus prevent the occurrence of negative side effects such as extinction bursts, aggression against trainers, and so forth.

That is, if trainers persist in presenting new tasks, escape behavior may eventually decrease without implementing extinction (i.e., even when escape is contingent on maladaptive behavior).

If an individual shows a tendency toward increased compliance and decreased maladaptive escape behavior as tasks become more familiar, it again may be possible to forego implementing extinction. Instead, strategies for facilitating acquisition of compliance, such as errorless learning (Touchette & Howard, 1984) and high-probability request sequences to establish behavioral momentum (Mace & Belfiore, 1990) may increase compliance and indirectly suppress escape behavior. If escape extinction is then deemed necessary (i.e., if escape behavior is not eliminated due to increases in compliance), then extinction may be used to complement the effects of reinforcement. Similarly, if an individual's behavior appears to come under schedule control following initially high rates of escape behavior, it may be possible to reduce the rate of responding under a continuous reinforcement schedule before implementing extinction. Finally, if an individual's maladaptive escape behavior does not appear to be sensitive to task novelty as an establishing operation, and if neither percentages of escape or compliance change over time, then escape extinction or treatment approaches based upon other variables may be considered.

STUDY 3: EFFECTS OF SESSION DURATION ON SIB

The duration of training sessions may influence the effects of trial termination as negative reinforcement in three ways. First, session duration may have no effect on behavior. That is, levels of maladaptive behavior may be relatively constant regardless of session duration. Second, escape behavior may decrease during a session, suggesting that trial termination is more reinforcing early rather than later in a session. Third, escape behavior may accelerate during sessions, indicating that the reinforcing effects of trial termination increase during sessions.

Very little research has investigated the effects of the temporal extension of sessions on escape behavior. Dunlap et al. (1991) compared the effects of short versus long tasks on the disruptive behavior of a female adolescent with multiple disabilities. In the long-task condition, the subject was presented with workbook exercises and was instructed to work for 15 min. In the short-task condition, the instructor presented the subject with exercises that were expected to take approximately 5 min to complete. Results showed that disruptive behavior occurred frequently during long tasks but occurred rarely during short tasks. The authors noted that atypically high levels of disruption were seen in one short-task session in which the cue that the session was going to be short was ambiguous (i.e., when the subject received only presession verbal instructions about session length rather than a finite set of problems to work), suggesting that cues related to session requirements may interact with and alter the function of task demands. Thus, it is difficult to separate the effects of session duration from those of two types of presession instructions (i.e., "finish these problems" vs. "work for 15 minutes").

The present study investigated the effects of session duration on escape-maintained SIB by examining trends in responding during sessions of equal length. That is, within-session responding during 15-min sessions was examined to reveal trends that occurred as a function of time in session. Because time in session is a continuous variable, it was not possible to employ a traditional experimental design in which the effects of discrete independent variables are compared to baselines during which the independent variable is not present; rather, the effects of time in session are always present during sessions, and thus were investigated during repeated sessions within a single condition.

Method

Evelyn, Landon, Larry, Milt, and Stan participated in Study 3. The demand assessment procedures (described previously) were in effect throughout Study 3. Each subject received several task demands during each 15-min session. The pool of demands was derived on an individual basis through informal assessment (in which a variety of demands were presented, and those found to occasion SIB with particular subjects were noted) and through observation of subjects' responses during the demand assessment. These task demands were presented approximately every 30 s in a counterbalanced order. Contingent upon compliance, subjects received verbal praise and no further demands until the next scheduled trial. SIB always resulted in termination of (i.e., escape from) the current trial. For Milt, procedures were identical to the music condition described in Study 1.

Results and Discussion

The results for Study 3 are shown in Figure 3. Data are summarized in consecutive 30-s intervals and are presented in two formats. Frequency distributions of SIB are shown in the left column. Each histogram shows the number of responses that occurred in each consecutive 30-s interval, summed over sessions (range across subjects, 11 to 15 sessions). Cumulative records of SIB are shown in the right column. Data points on these graphs represent the sum of self-injurious responses for the current plus all preceding 30-s intervals. These data were also summed across sessions. These two formats for data display permit an inspection of within-session responding that reveals relationships between time in session and trends in SIB.

Evelyn's data represent responses summed over 11 sessions. The frequency distribution shows that Evelyn responded only once each in the 5th, 9th, and 19th intervals; however, two or more responses occurred in each remaining interval, increasing to a high of 36 responses in the 26th interval before showing a decrease at the end of sessions. Evelyn's cumulative record shows a virtually flat line during the first 10 min of sessions; thereafter, a rapid increase in SIB occurred until the final minute of sessions.

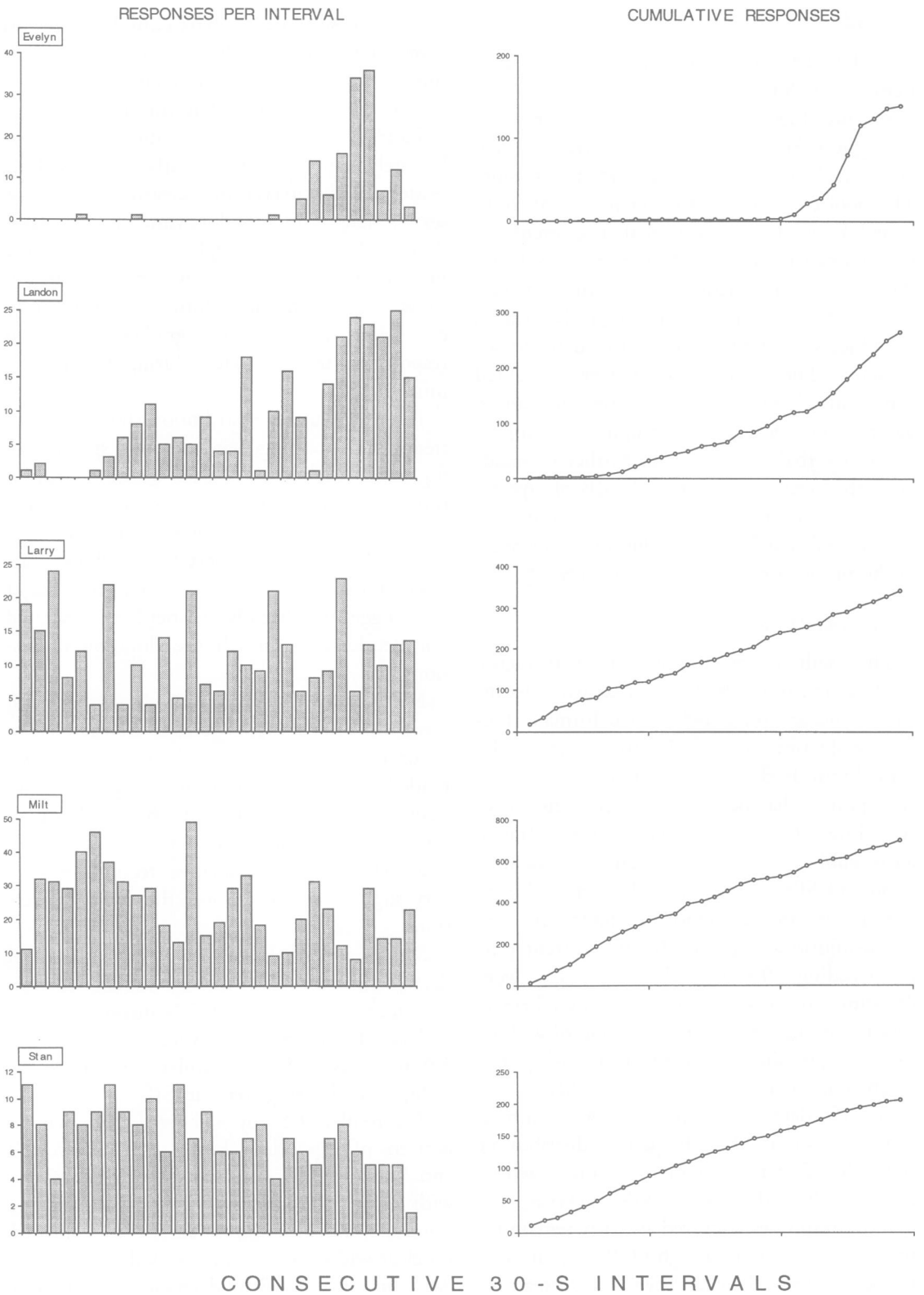
Landon's frequency distribution shows that he rarely responded during early intervals of his sessions, with intervals of increasing SIB seen as session length increased beyond 4 min. Landon's SIB reached its highest level during the final third of the session. His cumulative record shows a nearly flat line during the first 5 min of sessions, followed by a gradual increase in responding that escalated during the final 5 min.

Larry's frequency distribution shows no clear trend in responding, with periodic spikes during which high rates of SIB occurred (inspection of session-by-session data indicates that these data reflect bursts of responses that occurred during one, or a very few, sessions). Larry's cumulative record shows a relatively straight line, suggesting that his SIB neither accelerated nor decelerated through the duration of sessions.

Milt's frequency distribution shows that, with some exceptions, higher rates of SIB tended to occur during earlier intervals and lower rates tended to occur later in sessions (e.g., the mean frequencies of SIB during the first and last 10 intervals of sessions were 25.5 and 18.5, respectively). Milt's cumulative record shows a very slight deceleration over the course of sessions.

Stan's frequency distribution shows a gradual decrease in responding throughout the sessions. The mean frequencies of SIB during the first and last 10 intervals of sessions were 8.7 and 5.9, respectively. Stan's cumulative record shows a slight decelerating trend in SIB.

The results of Study 3 showed three general patterns of responding during sessions. Evelyn's and Landon's SIB accelerated during sessions, with most SIB occurring during intervals toward the end of sessions. Larry's data showed no clear within-session trends. Milt's and Stan's data showed very slight decreasing trends over


RESPONSES PER INTERVAL
CUMULATIVE RESPONSES
Evelyn
Landon
Larry
Milt
Stan
CONSECUTIVE 30-S INTERVALS

the duration of sessions. Thus, Study 3 showed that it is possible to observe clearly differentiated patterns in responding over time, even though the reinforcement contingency for SIB remained constant.

There are at least two explanations for increasing trends in escape-maintained SIB during sessions. First, the length of time during which trials are presented, or some other temporally related variable, may alter the reinforcing effects of trial termination, such that escape becomes a more powerful reinforcer as the session progresses. Put simply, it may be aversive to be in a demand session for a long time. Similarly, as the number of trials previously experienced (rather than the length of time over which they were presented) increases, the reinforcing effects of escape from upcoming demands may increase. Both of these explanations are consistent with an establishing operations account for observed changes in Evelyn's and Landon's behavior. Another possible account for accelerating SIB during sessions is that SIB comes under control of a molar escape contingency, in which the session itself represents a unitary stimulus condition that establishes its own termination as a reinforcing consequence (Mellitz, Hineline, Whitehouse, & Laurence, 1983). Responses that occurred contiguous with the end of a 15-min session may have been adventitiously reinforced, and thus "superstitious" escape behavior may have been produced. According to this account, each session may be viewed (from the perspective of the subject) as a single trial with a fixed-interval (FI) 15-min schedule of reinforcement (trial termination). Fixed-interval schedules produce patterns of responding in which initially low rates accelerate as time to reinforcement decreases, producing a scallop pattern in cumulative records. If Evelyn's and Landon's results are consistent with this account, another characteristic of their data should have been the emergence over successive sessions of a scallop pattern, becoming more prominent as discrimination of session length is acquired. Evelyn's session-by-session data did not show such a pattern; however, Landon's session-by-session data showed some evidence that the scallop pattern may have emerged over time. Thus, Landon's results were consistent with both establishing operations and adventitious reinforcement accounts (i.e., his SIB increased during sessions, and this pattern became more prevalent across subsequent sessions). The processes underlying these outcomes may have been clarified by unpredictably varying the length of sessions; in so doing, responding under the control of session termination would either have stabilized or disappeared (because no actual contingency would exist between SIB and session termination). If, on the other hand, temporally related variables altered the reinforcing effects of trial termination, SIB would have been positively correlated with session length, and the patterns observed in the current study would have been maintained at similar session durations.

Milt's and Stan's data showed slight decreases in SIB during sessions, suggesting that escape during initial moments of a session may have been a more powerful reinforcer than during subsequent moments. An alternative account for Milt's and Stan's data is that brief periods of escape were not sufficiently powerful reinforcers to maintain SIB; thus, their escape behavior was extinguished. This account, however, is based upon a learning process that

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Figure 3. Results of Study 3 for Evelyn, Landon, Larry, Milt, and Stan. The left column shows frequency distributions of SIB during sessions, summed over all sessions. The right column shows cumulative records of SIB during sessions, summed over all sessions. (Note: 29 rather than 30 intervals are represented on all graphs; due to a program error in the data collection computers, the first 28 intervals represent 31.4 s duration and the 29th interval represents 20.8 s).

should result in the virtual elimination of SIB over successive sessions as a function of previous experience with (from the subject's perspective) the extinction contingency. Neither Milt's nor Stan's behavior showed such a general decrease, with Milt continuing to exhibit high rates of SIB through 11 sessions and Stan continuing to exhibit moderate rates of SIB through 15 sessions.

The different response patterns generated by the subjects in Study 3 suggest that sensitivity to time in session as an establishing operation may be idiosyncratic. Such information may be useful in the development of treatment plans. For example, individuals who display patterns of responding similar to Evelyn's, in which responses almost never occurred early in sessions but increased dramatically in the final minutes, may benefit from brief but more frequent training sessions, rather than a few extended training activities per day. If extended sessions are necessary to teach a particular skill, then a fading program, in which initial sessions are brief and session duration is slowly lengthened, may suppress maladaptive behavior. Alternatively, for individuals whose escape responding is more prevalent in early moments of sessions, it may be helpful to limit the number of training activities conducted daily, and to arrange extended sessions for necessary activities. Thus, continued refinement of methods for identifying the effects of time-in-session and related variables may provide useful information for the management of maladaptive behavior maintained by escape.

The data from Study 3 must be interpreted with some caution due to their aggregation across sessions. That is, general statements are justified only if curves generated by summed data are typical of those produced by data from individual sessions. Comparison of single-session data for each subject showed no significant inconsistencies between intrasession trends and those shown in summed displays. However, any variability is of concern, and general conclusions must be tempered to the extent that a summary data set does not resemble each of its composite sets.

STUDY 4: EFFECTS OF THE RATE OF TASK TRIALS ON SIB

The rate at which task trials are presented may alter the reinforcing effects of escape from those trials. Increasing the rate of task presentation may increase the reinforcing effects of trial termination; that is, the percentage of trials that occasion escape responses may increase with increases in the rate of presentation of task trials. Alternatively, increasing the rate of task presentation may decrease the reinforcing effects of trial termination. Finally, it is possible that the rate of task presentation may be unrelated to the effectiveness of trial termination as a reinforcer and that no change in the percentage of task trials that occasion escape behavior will occur with changes in the rate of trial presentation.

Few studies have reported effects of task trial rate on problem behaviors. In an early investigation, Carnine (1976) examined the effects of task presentation rate on off-task behavior (walking around, moving chairs, jumping, blurting out, talking, ignoring the teacher, and other minor disruptions), correct answering, and participation (responding within 1 s of the teacher's cue to answer) of two "low-achieving" first grade children. A teacher presented reading tasks to students in a group format and signaled them to respond in unison to each task. Trials began when the teacher presented a task and ended when the subjects responded. Presentation rate was determined by pauses between trials; the delay was 5 s or more in the slow condition and 1 s or less in the fast condition. Results indicated that fast presentation rates were associated with decreases in off-task behavior and increases in participation and correct responding. However, lower levels of off-task behavior in the fast condition may have been due to variables other than a change in the rein-

forcing effects of trial termination. First, it is unclear that off-task behavior was maintained by escape from tasks because escape was not contingent upon off-task behavior. Second, subject behaviors were recorded throughout the teaching session. Thus, in the slow condition, off-task behavior that occurred during the 5-s pauses between trials would have been scored but would not be indicative of an escape function. Rather, it is likely that these behaviors occurred during breaks between trials and were maintained by unknown consequences.

Several studies have incorporated variations in rates of task presentation into treatment by way of a fading procedure (Pace, Iwata, Cowdery, Andree, & McIntyre, 1993; Pace et al., 1994; Zarcone, Iwata, Smith, Mazaleski, & Lerman, 1994; Zarcone et al., 1993). For example, Zarcone et al. (1994) found that low rates of demand presentation eliminated their subjects' SIB, but that escape extinction was necessary to maintain treatment effects as demand rates increased. By contrast, Pace et al. (1994) showed that demand fading without extinction effectively decreased an individual's escape-maintained obscenity. However, the fading treatment included embedding demands within a conversational context, which may have enhanced the effects of fading by further reducing the establishing operation for escape. Although these results suggest that fading in the rate of demand presentation may alter the reinforcing effects of trial termination, the effects of slow-versus fast-paced task trials as establishing operations have not been isolated. Study 4 compared the effects of two schedules of task presentation on the percentage of task trials that occasioned SIB.

Method

Stan, Olivia, Carl, Larry, and Helen participated in Study 4. Two conditions were conducted: a high-rate condition in which 30 trials were presented (i.e., fixed-time [FT] 30 s) and a low-rate condition in which 10 trials were presented (i.e., FT 90 s). The experimental procedures previously described for the demand condition were in effect throughout Study 4, with the exception of trial rate. As in Studies 1 and 3, subjects received task demands during 15-min sessions that were taken from a pool of demands previously shown to evoke SIB (as described in the Method section of Study 3). SIB always resulted in escape from the current trial, and compliance produced verbal praise and withdrawal of tasks until the next scheduled trial. For Stan, Olivia, and Carl, the conditions were presented in an A-B design (across 15 sessions, 26 sessions, and 12 sessions, respectively), with the high-rate condition preceding the low-rate condition. For Larry and Helen, the experimental conditions were presented in a multielement format (across 16 sessions and 21 sessions, respectively), in which conditions were rapidly alternated.

Data were collected on the percentage of task trials that occasioned SIB (i.e., percentage of trials escaped) and on the percentage of task trials with compliance. Trials occasioning SIB or compliance were coded, and the number of trials with each was summed across sessions for each person. The results were divided by the total number of task trials presented, yielding the percentage of task trials with SIB and compliance. Percentage of trials with escape was used as the primary dependent variable, and percentage of trials with compliance was used to determine the extent to which changes in escape behavior might be attributed to differences in reinforcement for compliance across conditions.

Results and Discussion

Results of Study 4 are presented in Figure 4. For Stan, the high-rate condition often produced SIB (75.6% of trials with SIB), whereas the low-rate condition seldom occasioned SIB (10% of trials with SIB). Stan's compliance was lower in high-rate than in low-rate conditions (9.7% vs. 67.8% of trials with compliance, respectively). Olivia's data show similar but less pronounced effects, with 49.6% of trials in the high-rate condition occasioning SIB and 23.8%

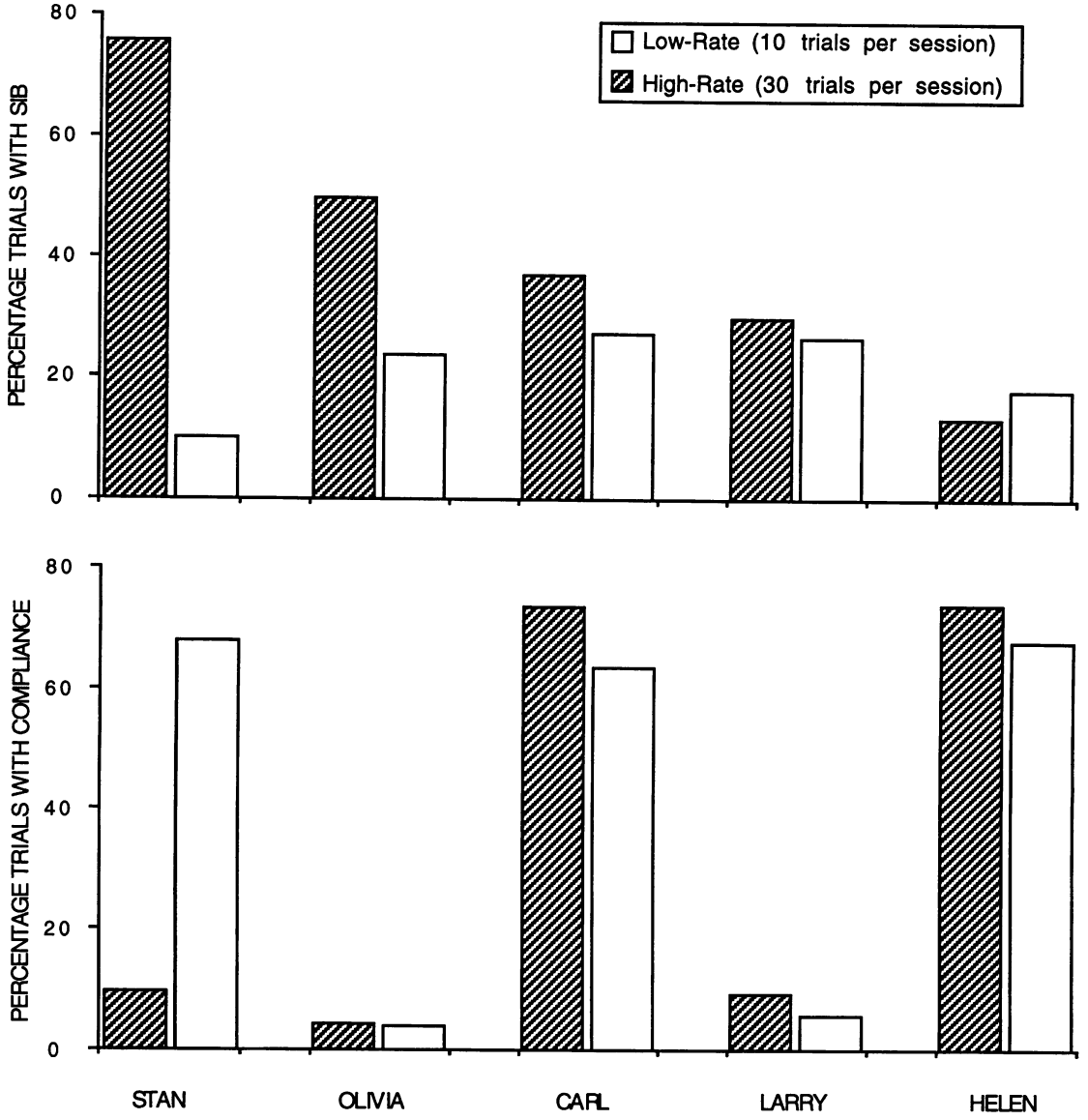

Figure 4. Results of Study 4 for Stan, Olivia, Carl, Larry, and Helen. Percentages of trials with SIB and percentages of trials with compliance are shown in the top and bottom panels, respectively. Striped bars represent responding in the high-rate condition (30 trials per session), and open bars represent responding in the low-rate condition (10 trials per session).

of trials in the low-rate condition occasioning SIB. Olivia's compliance was 4.3% in the high-rate condition and 3.9% in the low-rate condition. Carl engaged in SIB during 37.1% of trials in the high-rate condition and during 27.5% of trials in the low-rate condition with SIB. His compliance was 73.6% in the high-rate and 63.3% in the low-rate condition. Larry exhibited similar amounts of escape in the high-rate and low-rate conditions (30% and 26.7% of trials occasioning SIB, respectively). Larry's compliance was 9.2% in the high-rate condition and 5.8% in the low-rate condition. Helen's data show a slight reversal in outcomes relative to other subjects. Although the difference in percentages of escape was small, the high-

rate condition was less likely to occasion SIB (13.5% of trials with SIB) than was the low-rate condition (18% of trials with SIB). Helen's compliance was 73.7% in the high-rate condition and 67.7% in the low-rate condition.

Results of Study 4 show that the rate at which task trials are presented may affect escape behavior independent of session duration. Data for Stan, Olivia, and Carl show differences in percentages of trials escaped, with high rates of task presentation producing more SIB. The data for Larry show a slightly higher percentage of high-rate trials with SIB, and Helen's data show a slightly higher percentage of low-rate trials with SIB; for these 2 subjects, differences were insufficient to infer that escape behavior had been changed as a function of trial rate.

Interpretations of the data for Study 4 must be tentative due to limitations in the experimental procedures. As in Study 2, data were summed within conditions, so variability among sessions is obscured. Thus, only in cases in which data are unambiguous may general conclusions be justified. Also, for Stan, Olivia, and Carl, the experimental design did not include reversals, which may have affected the results. Because the low-rate condition always followed the high-rate condition, it is possible that subjects learned to comply with task requests, resulting in lower percentages of trials with SIB in the low-rate condition. Examination of compliance across conditions indicates that this may have occurred for Stan, whose data revealed a 58.1% difference in compliance between conditions, with low trial rates associated with a higher level of compliance. Thus, it is not possible to determine whether the difference in Stan's compliance was due to a learning effect or to an unknown variable associated with the rate of trials. Percentages of compliance for Olivia and Carl showed only slight differences in compliance, with high-rate conditions occasioning slightly higher compliance percentages. These data are consistent with an establishing operations account of increased percentages of trials with SIB in high-rate conditions, because increases in reinforcement for compliance did not occur (and thus cannot account for lower percentages of trials with SIB) in the low-rate conditions. An improved experimental design using reversals or a multielement format would permit more definitive interpretations by controlling for learning and sequence effects.

A more general concern with Study 4 is the potential confounding between task presentation rate and the duration of intertrial intervals. That is, durations between trials were greater in the low-rate condition than in the high-rate condition, which may be viewed as an alteration of the magnitude of reinforcement (i.e., longer periods of escape were available in the low-rate condition). Such an effect would be expected to produce less responding in the high-rate condition and more responding in the low-rate condition, because of differences in durations of escape. Thus, establishing operations associated with rate of task trials may be obscured (however, this account actually increases the confidence in an establishing operations interpretation for data showing more escape behavior in the high-rate condition). Equalization of intertrial intervals would control for magnitude of reinforcement, but would itself introduce confounding with session duration, which was shown to alter the reinforcing effects of escape for some subjects in Study 3. Similarly, the rate of task trials in Study 4 is confounded with the number of trials (both rate and number of trials are greater in the high-rate condition); again, resolution of this confounding effect would produce asymmetry in session duration between conditions. Thus, a more definitive investigation of the effects of task trial rate may necessitate comparisons among a series of conditions, none of which may be free of confounding effects when viewed in isolation.

Larry's and Helen's data suggest that their behavior may have been relatively insensitive to the rate at which task trials were presented. Interestingly, these 2 subjects experienced the two experimental conditions in a multielement format, whereas Stan, Olivia, and Carl all experi-

enced the conditions in an A-B design. These effects may represent actual differences in the effects of the rate of trials, or they may have been artifactually produced either by previously described limitations of the A-B design or by rapid alternation of conditions in the multielement format that may have reduced discrimination between low- and high-rate conditions (Ulman & Sulzer-Azaroff, 1975).

Although limitations in the current study preclude definitive conclusions about the establishing properties of trial rate, it is presented as a basic model for further refinement. Future investigations of the effects of task trial rate on escape behavior might best utilize a reversal format (A-B-A-B) in which each condition is replicated at least once following experience with the other, counterbalancing condition order across subjects. This design minimizes both learning effects and potential problems due to interference among conditions. In addition, the integration of distinctive but functionally irrelevant stimuli (e.g., different rooms, different therapist uniforms) into each condition may facilitate discrimination. Finally, innovative methods for controlling potential confounding effects (such as reinforcement magnitude and session duration) would advance future investigations on the effects of different task trial rates.

Information from an assessment of the establishing operations of task trial rate may be useful in the development of training routines and treatments for behavior problems that are maintained by escape. If, for example, high rates of task presentation occasion higher levels of escape behavior, then it may be appropriate to arrange for training programs to be conducted at a slow pace, thus minimizing motivation for escape. If it is necessary to present demands at higher rates, then methods for systematically fading in the frequency of demands may be indicated (e.g., Pace et al., 1993).

GENERAL DISCUSSION

The current series of studies illustrates a method for identifying establishing operations for behavior disorders such as SIB. Given the continued availability of reinforcement (escape from task demands), variables examined in these studies were the novelty of tasks, the time course of sessions, and the rate of task trial presentation. The results suggest that these variables may alter the effects of negative reinforcement in ways that may be idiosyncratic across individuals.

The method described here may be useful for identifying the potential establishing operations of a wide range of antecedent variables within the demand context. By maintaining a contingent relationship between behavior and escape as a reinforcing consequence, it should be possible to determine the extent to which variables such as task effort, complexity, varying motor requirements (i.e., gross- vs. fine-motor tasks), and so on serve as establishing operations. Further, the effects of these antecedent events could be examined in isolation and as compound events, to determine how such variables interact to alter the functional properties of each. For example, it is possible that the effects of novel demands can be altered as a function of response effort (e.g., less effortful novel tasks may evoke less escape behavior than more effortful novel tasks). A determination of the functional properties of novel demands across different measures of effort may reveal such effects.

Another potential extension of the current method is in the assessment of establishing operations for maladaptive behavior maintained by positive reinforcement. For example, by maintaining a contingent relationship between SIB and attention, it may be possible to examine the effects of social deprivation, therapist characteristics (e.g., novelty), availability of alternative forms of stimulation (e.g., peer attention, toys), time in session, and other antecedent events that might alter the reinforcing effects of attention. Again, it may be possible to conduct investigations into the differential effects of compound variables if the functional properties of the elements are known.

The methods described in this series of stud-

ies appear to have relevance for the investigation of variables known as *setting events.* Kantor has suggested that the customary methods of behavior analysis cannot capture the interactive and elaborate nature of the relationship between environment and behavior (Kantor, 1970, p. 105), and introduced setting events as disparate influences on behavior, many of which seemed to have motivational properties. Although Kantor's concept of the setting event provides an umbrella term for a range of antecedent influences over behavior, it lacks a functional basis for inclusionary criteria. That is, the behavioral mechanisms by which setting events influence behavior are not specified in Kantor's account; these events may exert stimulus control over behavior, or they may be motivating influences, or both. Setting events are most often described in terms of structural features, including their temporal relationship with behavior (e.g., they occur antecedent to or concurrent with behavior) or their physical dimensions (e.g., they may occur physically distant from the behavior they ultimately affect), rather than according to basic behavioral relations. Thus, the functional properties of these events require further analysis.

The current series of studies may provide a general method that can be extended to assess complex relationships among antecedent events and behavior, and thus exemplifies an incremental approach to the functional analysis of setting or context. That is, it may be possible to build a model of context experimentally by combining elements with known functional properties. This approach offers an advantage in that interpretations of the basic behavioral properties that underlie changes in behavior may be made with increased confidence. Because much current research on contextual (or setting) variables investigates the effects of complex antecedents but does not assess the functions of the variables that comprise these events, and because the maintaining consequences for target behaviors are often unknown, uncontrolled, or completely absent, it is rarely possible to conclude more than that behavior changed when context changed. That is, structural (or correlational) relationships between environmental events and behavior are shown. This is useful information in a technical sense; a demonstration that a procedure may modify the behavior of one or more individuals suggests that a similar procedure also may modify the behavior of others with similar problems. A relationship between environmental events and behavior usually is apparent; however, the basic processes that underlie behavior change are not.

An alternative approach to the study of antecedent effects on behavior may be to identify incrementally the functional properties of events within the environment. Although it is tempting to propose elaborate constructs (e.g., setting events, behavioral fields, etc.) to account for complex behavior, a complete account of behavior results from incremental isolation and analysis of functional variables. Thus, it seems to be prudent (if painstaking) to pursue an understanding of complex behavior by building explanations based on elemental analyses, rather than to propose elaborate hypothetical constructs that do not contain, but ultimately require, explication based upon fundamental principles.

A detailed account of the functional properties of antecedent events may not appear to be important from an applied perspective. However, mere demonstrations of behavior change without an understanding of the functional properties of intervention provides little basis for selecting among possible treatment procedures. We are left to sample procedures until we find success; if an initially successful procedure fails to maintain its effects, we know neither why the failure occurred nor how to effect repairs. From such situations the need to use default treatments (e.g., punishment) arises (Iwata, 1988).

A careful analysis of establishing operations for behavior disorders may be particularly important from an applied standpoint. If it is possible to manipulate directly the variables that motivate maladaptive behavior, then the nega-

tive side effects sometimes associated with the use of extinction and punishment may be avoided. That is, manipulations of establishing operations may reduce the necessity of altering contingencies or implementing new ones to reduce maladaptive behavior. Methods to identify the functional properties of antecedent events may produce information that is important in developing and assessing the effectiveness of treatments based on establishing operations.

Although the current set of studies contains several limitations that require cautious interpretation of the data, the results offer preliminary insight into variables that may alter the reinforcing effects of escape for individuals whose behavior is maintained by negative reinforcement. Perhaps more important, a general method for the study of such variables is presented, in which the maintaining consequences remain intact during assessment of antecedent influences. Thus, its primary contribution may be as an incremental advance toward an analysis of establishing operations. With further refinement and extension, this method may prove to be useful for identifying a range of establishing operations for behavior maintained by escape, and may be also be adaptable for assessing the establishing properties of antecedents to maladaptive behaviors that are maintained by contingencies other than escape. Finally, if this method is useful for assessing establishing operations in isolation, then research on the effects of more complex antecedent events may proceed in a manner that will permit eventual analysis of contextual variables in terms of basic behavioral processes.

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